Claims 1, 3-4, 6, 8-17 and 19 are currently pending in the above-identified application.

The specification has been amended to delete several sections and to place the above-mentioned drawing elements in the specification in close proximity to its corresponding reference numerals. Reconsideration and withdrawal of the objections to the specification are respectfully requested.

By the present amendment, claims 2, 5, 7 and 18 have been cancelled. Claims 1, 3, 6, 8-9, 12, 14, 16-17 and 19 have been amended. Support for the amendments to claim 1 may be found in original claims 1, 2 and 7. Support for the amendments to claims 3, 6, 8-9, 12, 14, 16-17 may be found in the specification and the figures as set forth in the following section of this amendment.

The Examiner has objected to the drawings because the drawings do not show every feature of the invention that is specified in the claims. The Examiner's objections to the drawings and responses thereto are as follows:

With respect to claim 1, the Examiner asserts that the "reformed gas supply element" and "reformed gas supply pathway" must be shown on the drawings. Applicants submit that the reformed gas is supplied to the reaction chamber through the "reformed gas inlet 2" shown on Figure 1. The "reformed gas pathway" leads from the inlet through the reaction chamber and exiting at the reformed gas outlet 10, also shown on Figure 1. Therefore, the "reformed gas supply element" and "reformed gas pathway" are shown on Figure 1 and pathway

12 has been labeled in Fig. 1. Attached hereto is a proposed change to Figure 1, wherein reference numeral 12 is added to Figure 1.

With respect to claim 2, the Examiner asserts that the "means for cooling the catalyst layer at the upstream side" must be shown on the drawings. Applicants submit that the cooled water volume control valve 6, that is a part of the water-cooled apparatus, is connected to the heat exchanger 7 itself. The water-cooled apparatus cools the reformed gas and the cooled reformed gas cools the upstream side of the catalyst bed. Thus, the catalyst bed is cooled indirectly. Therefore, the means for cooling the catalyst bed at the upstream side is implicitly shown on the drawings.

With respect to claim 5, the Examiner asserts that the heating means (defined in the specification as a heater) is recited as utilizing reaction heat generated by reaction of carbon monoxide and hydrogen, but claim 2, from which this claim depends, utilizes a heater as shown in claim 1. The Examiner's objection as applied to claim 2 and 5 is moot since claims 2 and 5 have been cancelled by the present amendment.

With respect to claim 12, the Examiner asserts that the two branches are not labeled in the drawings. Attached hereto is a proposed change to Figure 8, wherein a second reference numeral 108 is added to Figure 8. By the present amendment, applicants submit that the two branched pathways 108 function as the cooling branch and the heating branch.

In light of these amendments and arguments, the applicants have fully complied with 37 C.F.R. §1.83(a). It is requested that the amendments to the drawings be entered and the arguments considered and that the Examiner's objections be reconsidered and withdrawn.

Rejection Under 35 U.S.C. §112, Second Paragraph

The Examiner has rejected claims 1-19 under 35 U.S.C. §112, second paragraph, as being indefinite. While not agreeing that these claims are indefinite, Applicants have cancelled claims 2, 5, 7 and 18 and amended claims 1, 3, 6-9, 12, 14, 16-17 and 19.

Claim 1 has been amended to replace the word "layer" with "bed." A catalyst layer can also be referred to as a catalyst bed.

Claim 3 has been amended to replace "upstream side of the catalyst layer" with "upstream portion of the catalyst bed" and "downstream side of the catalyst layer" with "downstream portion of the catalyst bed." Applicants have removed the word "the" in front of activity and replaced it with the word "an," thereby providing antecedent bases for the activity element.

Claim 6 has been amended to replace "wherein a supplying amount of said oxidant gas is changed" with "comprising an air flow rate control valve capable of changing an amount of air to be supplied." Support for the amendment to claim 6 may be found at least in the specification at page 15, lines 1-10.

Claim 8 has been amended to replace the word "layer" with "bed." One skilled in the art recognizes the appropriate directions dependent on temperature gradients. All that claim 8 is intended to convey is countercurrent flows.

Claim 9 has been amended to replace the term "on the periphery" with "outside the reformed gas pathway." Support for this amendment may be found in Figure 4. Claim 9 has been amended to replace "before the passage" with "before passing." Support for this amendment may be found in Figure 3.

Claim 12 has been amended to replace the word "layer" with the word "bed."

Claim 14 has been amended to replace "the uppermost catalyst layer" with "an uppermost catalyst layer," thereby providing antecedent bases for the element.

Claim 16 has been amended to precisely recite that the open area of the honeycomb lattice of the uppermost catalyst bed is larger than that of the lowermost catalyst bed. Support for the amendment to claim 16 may be found in the specification at page 8, lines 14-16.

Claim 17 has been amended to replace "the alumina group material" and "the zeolite group material" with "an alumina group material" and "a zeolite group material" respectively, thereby providing antecedent bases for the elements.

The §112 rejection of claims 7 and 18 are moot since claims 7 and 18 have been cancelled.

Other amendments to the claims have been made to conform to the language of preceding claims. In light of the foregoing amendments, the claims are in compliance with 35 U.S.C. § 112, second paragraph. Reconsideration and withdrawal of the rejections are requested.

<u>Rejection Under 35 U.S.C. §102</u>

The Examiner has rejected claims 1, 2 and 5-9 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 5,874,051 of Heil et al. ("Heil"). The Examiner asserts that with regard to claim 1, Heil discloses a hydrogen purifying apparatus for oxidizing and removing carbon monoxide in a reformed gas containing carbon monoxide in addition to the main component of hydrogen gas; the apparatus comprising a reaction segment (Figure 1(5)) having a catalyst layer for oxidizing carbon monoxide, a reformed gas supply segment (2) for supplying the reformed gas to the reaction segment via a reformed gas supply pathway; and an oxidant gas

supplying segment (3) for supplying an oxidant gas on the path of the reformed gas supply pathway. Applicants respectfully, but strenuously traverse the §102(e) rejection of claims 1, 2 and 5-9 for the reasons set forth in detail below.

Heil discloses an apparatus for selective catalytic oxidation of carbon monoxide in a mixed gas stream containing hydrogen (Heil, claim 1). The apparatus comprises a carbon monoxide oxidation reactor 1. The carbon monoxide reactor 1 consists of three oxidation stages marked I, II, and III (Fig. 1, and col. 3, lines 17-18). The mixed gas stream containing hydrogen is supplied to the carbon monoxide reactor in the vicinity of the first oxidation stage I (col. 3, lines 21-23). In the individual oxidation stages I-III, the carbon monoxide is reduced in stages by selective oxidation on suitable catalysts (col. 3, lines 29-31). The oxidizing gas is added to the mixed gas stream through inlet openings 3. Heil discloses that it is advantageous to apply the catalyst to metal catalyst support units 5.

The present invention recites a hydrogen purifying apparatus for oxidizing and removing carbon monoxide comprising a reaction segment having a catalyst bed for oxidizing carbon monoxide, a reformed gas supplying segment, an oxidant gas supplying segment, a water-cooling apparatus for cooling an upstream side of the catalyst bed, and means for heating a downstream side of the catalyst bed (claim 1). The metal catalyst support units 5 disclosed in Heil are not the reaction segment recited in the present invention. The metal catalyst support units 5 disclosed in Heil are used to guide the flow, thus making it possible to improve the material exchange in reaction chamber 2 as well as the heat exchange of the mixed gas stream with the walls of reaction chamber 2 (col. 3, lines 44-48).

Significantly, Heil uses the reaction heat that is generated by the oxidation reaction of the carbon monoxide to heat the catalyst units. The heating means (i.e. the reformed gas before cooled or the electric heater) of claim 1 does not utilize heat generation due to the oxidation of the carbon monoxide. The oxidation of the carbon monoxide is facilitated by cooling the catalyst bed at the upstream side, and heating the catalyst bed at the downstream side (specification at page 11, lines 10-12). Therefore, the temperature can be readily controlled and thus the operation can be conducted stably. Heil does not teach that the reaction heat can be generated outside of the oxidation reaction by heating means. Thus, Heil does not teach each and every element of claim 1. Therefore Heil does not anticipate claim 1.

With regard to claim 2, the Examiner asserts that Heil discloses a fluid means for cooling the catalyst layer (column 3, lines 50-65). The Examiner contends that Heil's control of the oxidation of CO and hydrogen at various locations along the reactor path, including the downstream side of the catalyst layer (Heil Abstract), thereby heating the catalyst layer with heat given off by CO oxidation, amounts to a heater. The Examiner's §102(e) rejection of claim 2 is moot since claim 2 has been cancelled by the present amendment and the rejection is responded to above.

With regard to claim 5, the Examiner asserts that Heil discloses heating the catalyst using reaction heat generated by the reaction of carbon monoxide and hydrogen in the reformed gas with the oxidant gas (Heil abstract). The Examiner's §102(e) rejection of claim 5 is moot since claim 5 has been cancelled by the present amendment.

With regard to claim 6, the Examiner asserts that Heil discloses supplying an amount of oxidant gas that changes in response to the temperature of the catalyst layer (col. 4,

lines 28-49). The Examiner argues that changing the flow rate is a procedural step and not a structural element of the claimed apparatus and that procedural steps do not serve to patentably distinguish the apparatus from the prior art. Claim 6 has been amended to recite the structure for effecting this change.

Heil discloses controlling the course of the reaction throughout the entire carbon monoxide-oxidation reactor 1 with the static mixers 8 (col. 4, lines 28-30). The static mixers permit simple adjustment of the inlet temperature of the mixed gas stream, so that the gas stream can be cooled to the desired temperature before it reaches the catalyst (col. 4, lines 31-34). Heil is interpreted to teach that the temperature is controlled by changing the amount of air to be supplied according to the catalyst temperature. For example, if the amount of air to be supplied with respect to carbon monoxide becomes lower than a certain amount, the reaction rapidly ceases and the temperature decreases. According to the present invention, the heating means provided at the downstream side of the catalyst prevents a rapid temperature decrease, so that the operation can be conducted stably, even when the amount of oxidant gas supply becomes lower than a certain amount. Heil does not suggest varying a supply amount of oxidant gas with a temperature of the catalyst layer. Thus, Heil does not teach or suggest each and every element of claim 6. Therefore, Heil does not anticipate claim 6.

With regard to claim 7, Heil discloses a flow pathway of the reformed gas at a position adjacent to the catalyst layer (Heil Figure 1). The Examiner asserts that in order for the reformed gas to interact with Heil's catalyst, the gas would have to flow adjacent to the catalyst layer. The Examiner also asserts that a partition (Figure 1) is needed to form the chamber that contains the reformed gas. The Examiner's §102(e) rejection of claim 7 is moot since claim 7

has been cancelled by the present amendment, and the rejection is overcome by amended claim 1.

With respect to claim 8, the Examiner asserts that Heil discloses passing the reformed gas through the catalyst layer in a second direction (Figure 1). The Examiner contends that Heil's cooling chamber is a static mixer and that in the static mixer the gas flows in many directions, including a direction opposite to the direction downstream in the cooling chamber.

Heil discloses static mixing structures 8 provided in the inlet area of oxidation stages I and II that help to mix the oxidizing gas with the rest of the mixed gas stream to enrich it and guide the flow (col. 3, lines 66-67 to col. 4, lines 1-2). The static mixers of Heil help to guide the flow and do not suggest as does claim 8 that the "reformed gas passes through the catalyst layer in an opposing direction." Further, claim 8 relates that the opposing direction of the stream is effectively used for the heat exchange. Thus, Heil does not teach or suggest each and every element of claim 8. Therefore, Heil does not anticipate claim 8.

With respect to claim 9, the Examiner asserts that Figure 1 of Heil discloses the reaction segment placed on the periphery of the flow pathway before passing through the catalyst layer.

Heil discloses a reaction chamber with catalyst support units, not a reaction segment as Examiner states (col 3, lines 41-44). Heil discloses that the mixed gas stream contacts the outside walls of the reaction chamber 2 (col. 4, lines 9-10). Claim 9 recites that reaction segment is placed outside the reformed gas pathway before passing through the catalyst bed and that the gas is supplied to the catalyst bed after passing through the cooling means. Heil does not disclose that the gas is supplied to its catalyst units after passing through a cooling

means. Therefore, Heil does not teach each and every element of claim 9. Therefore, Heil does not anticipate claim 9. Reconsideration and withdrawal of the rejection are respectfully requested.

Rejection Under 35 U.S.C. §103 Over Heil In View of Trocciola

The Examiner has rejected claims 3 and 4 under 35 U.S.C. § 103(a) as being unpatentable over Heil, in view of U.S. Patent No. 5,330,727 of Trocciola *et al.* (" Trocciola"). The Examiner acknowledges that Heil fails to include catalyst layers formed of different catalyst materials. The Examiner asserts that Trocciola discloses two different catalyst beds under different catalyst conditions that lead to different performance results (col. 6, lines 1-36). The Examiner contends that it would have been obvious to one of ordinary skill in the art to combine the operation of the two different catalyst beds in Trocciola with Heil. Applicants respectfully, but strenuously traverse the §103(a) rejection of claims 3 and 4 for the reasons set forth below.

As discussed above, Heil does not teach each and every element of the present invention and Trocciola does not overcome the deficiency. Trocciola relates to an apparatus for removing carbon monoxide from gaseous media using two stages. Heat exchange coils 24 and 34 reside in stages 20 and 30 respectively, and a heat exchanger 40 is located between the stages, but all three of these devices are for cooling, not for heating the catalyst layer at the downstream side. Additionally, although Trocciola describes two separate catalyst beds operating at different temperatures, Trocciola does not describe the catalyst in the upstream layer being formed of different materials from the catalyst in the downstream layer, where the downstream side catalyst exerts activity at a lower temperature than the catalyst in the upstream side, as in claim 3 of the presently claimed invention.

There is no motivation to combine Heil and Trocciola as suggested by the Examiner. Trocciola is directed to a selective oxidation reaction, which is exothermic by nature, and takes place in two catalyst beds 22 and 32 under well defined temperature conditions. Heil is directed to a selective oxidation reaction controlled by the reaction path of a mixed gas stream. Thus, these inventions utilize two different methods to perform the respective selective carbon monoxide oxidation. Therefore, Heil would not suggest using multiple catalyst beds in its selective oxidation reaction as suggested by the Examiner.

At the time the invention was made, one of ordinary skill in the art presented with the disclosures of Trocciola and Heil would have had no reasonable expectation that the combination of Trocciola and Heil would give rise to the successful characteristics of the instant claims, namely efficient oxidation and stable removal of undesirable CO in the reformed gas (specification at page 11, lines 13-15). Neither the disclosure of Trocciola nor the disclosure of Heil recognizes the importance of using means for cooling the catalyst layer at the upstream side, and means for heating the catalyst layer at the downstream side. Thus, neither Trocciola nor Heil, taken alone or in combination recognizes that such means facilitates efficient oxidation and stable removal of undesirable CO in the reformed gas. Reconsideration and withdrawal of the rejection are respectfully requested.

<u>Rejection Under 35 U.S.C. §103 Over Heil In View of Kobylinski</u>

The Examiner has rejected claims 7-11 under 35 U.S.C. § 103(a) as being unpatentable over Heil, as applied to claims 1 and 2, in view of U.S. Patent No. 3,910,770 of Kobylinksi *et al.* ("Kobylinksi"). The Examiner asserts that Heil discloses essentially the same apparatus as the present invention. The Examiner acknowledges that Heil does not expressly

disclose a flow pathway of the reformed gas formed close to the catalyst layer via a partition in order to heat the catalyst. However, the Examiner asserts that Kobylinski discloses a catalyst system for processing a heated gas wherein the gas travels a pathway close to the catalyst layer and heats the layer through a partition in order to heat the downstream side of the catalyst layer (col. 5, lines 15-26). The Examiner argues that it would have been obvious to one of ordinary skill in the art to combine the catalyst heating structure of Kobylinski with the apparatus of Heil. Applicants strenuously, but respectfully traverse the §103(a) rejection of claims 7-11 for the reasons set forth below.

Heil does not disclose a reformed gas pathway in proximity to the catalyst layer via a partition so as to heat the down stream side of the catalyst layer. Thus, Heil does not teach each and every element of the present claims and Kobylinski does not overcome the deficiency. Kobylinksi discloses a two-stage converter for removal of virtually all undesirable components from the exhaust gases of internal combustion engines. Kobylinski discloses a preference for producing a temperature inside the catalyst bed in the deduction reaction zone (col. 5, lines 15-17). Kobylinski discloses the use of elevated temperatures to selectively reduce forming nitrogen oxides to nitrogen without formation of significant amounts of ammonia (col. 3, lines 32-37). Kobylinski is silent concerning the necessity to heat the down stream side of the catalyst layer.

There is no motivation to combine Heil and Kobylinksi as suggested by the Examiner. Kobylinksi is directed to a two-stage converter for removal of virtually all undesirable components from the exhaust gases by utilizing the heat formed by the reaction. Heil is directed to a selective oxidation reaction controlled by the reaction path of a mixed gas

stream. Thus, these inventions are directed towards two different problems. Therefore, one of ordinary skill in the art would not have been motivated to combine the catalyst heating structure of Kobylinski with the apparatus of Heil as suggested by the Examiner.

At the time the invention was made, one of ordinary skill in the art presented with the disclosures of Heil and Kobylinski would have had no reasonable expectation that the combination of Heil and Kobylinski would give rise to the instant claims. Kobylinski's use of the reaction heat generated by the oxidation reaction as a means for heating the catalyst, generates varied heat depending on the reaction rate of the oxidation reaction. Heil also utilizes the reaction heat generated by the oxidation reaction. This is typical of the prior art problems that the present invention addresses. Thus, one of ordinary skill in the art would not have expected that combining Heil and Kobylinski would produce a stable reaction, with heating means other than a reaction heat at the downstream side of the catalyst, wherein the temperature can be readily controlled. Reconsideration and withdrawal of the rejection are respectfully requested.

Rejection Under 35 U.S.C. §103 Over Heil

The Examiner has rejected claims 12-19 under 35 U.S.C. §103(a) as being unpatentable over Heil as applied to claims 1 and 2. The Examiner asserts that Heil discloses a hydrogen purifying apparatus wherein there are a plurality of branches that supply gas from a reformed gas supply pathway and an oxidant gas supply; a reaction segment with at least a two-segmented catalyst layer and at least the uppermost catalyst layer having a part with no catalytic function or a part with low reactivity to CO (col. 4, lines 2-5); a catalyst layer composed of catalyst pellets (col. 3, lines 40-47) and metal support units; multiple catalyst segments (Fig. 1);

catalyst layers comprising a platinum group metal supported by an alumina material and a platinum group supported by a zeolite (col. 53, lines 39-41); and an uppermost catalyst layer heated to a higher temperature than the lowermost catalyst layer (col. 1, lines 50-57). The Examiner further asserts that Heil discloses essentially the same apparatus as the present claim but fails to expressly disclose a branched pathway which bifurcates downstream from a connection between the reformed gas supply and the oxidant gas supply. The Examiner contends that it would have been obvious to one of ordinary skill in the art to split the flow path downstream from a connection between the reformed gas supply and the oxidant gas supply in order to supply a group of catalyst portions. Applicants respectfully, but strenuously traverse the §103(a) rejection of claims 12-19 for the reasons set forth below.

Heil discloses an apparatus that has the structure in which a plurality of oxidant gas inlets are provided at the pathway to the purifying segment in order that the reformed gas and the oxidant gas will not be mixed together, except inside the purifying segment (col. 3, lines 66-67 and col. 4, lines 1-2).

In contrast, the present invention has the structure in which the reformed gas and the oxidant gas are mixed together outside of and prior to the purifying (reaction) segment. Further, the mixed gas is supplied directly to the purifying segment.

As discussed above, Heil does not teach each and every element of the instant claims. Further, Heil does not disclose or suggest branching off the gas pathways to supply the mixed gas to the downstream side of the catalyst in the apparatus having the structure of the present invention, thereby, (1) reducing a temperature rise of the catalyst and (2) preventing the development of catalyst reaction in the absence of oxygen (specification at page 26, lines 7-9).

With regard to claim 14, there is no reference in the portions of Heil, cited by the Examiner or anywhere in Heil, of a two-segmented catalyst layer or an uppermost catalyst layer having a part with no catalytic function or a part with low reactivity to CO. Heil merely disclose that the support of the static mixing structures for producing a mixed gas is a carrier that is not coated with a catalyst (Heil, col. 4, lines 2-5). Heil does not teach or suggest a two-segmented catalyst bed as claimed, nor an uppermost catalyst bed in claim 14 of the present invention. Thus, Heil does not disclose or suggest the above-mentioned effects (1) and (2) can be achieved by forming in the catalyst bed a portion that is not coated with a catalyst such as 116C in Figure 1 of the present invention. Thus, Heil does not teach each and every element of claim 14.

Further, one of ordinary skill in the art would not have been motivated to modify Heil to arrive at the instant claims. The present invention relates the branched pathway to form a catalyst bed heating branch and a catalyst bed cooling branch. Heil does not disclose the need for a heating branch and a cooling branch. Therefore, one of ordinary skill in the art would not have been motivated to split the flow path, as suggested by the Examiner, to form a heating branch and a cooling branch.

Additionally, at the time the invention was made, one of ordinary skill in the art presented with the disclosure of Heil would have had no reasonable expectation that the modification of Heil as suggested by the Examiner would give rise to the successful results of the claimed invention, namely (1) reducing a temperature rise of the catalyst and (2) preventing the development of catalyst reaction in the absence of oxygen (specification at page 26, lines 7-9). Reconsideration and withdrawal of the rejection are respectfully requested.

Even if *prima facie* obviousness could be shown based on the above-noted references, despite the Examiner's comments concerning the referenced prior art, it is applicants' continued position that such *prima facie* obviousness is sufficiently overcome by applicants' hydrogen apparatus that provides efficient oxidation and stable removal of undesirable CO in the reformed gas (specification at page 11, lines 13-15).

CONCLUSION

In view of the foregoing Amendments and Remarks, Applicants respectfully submit that the present application, including claims 1, 3-4, 6, 8-17 and 19 is in condition for allowance, and request an early notice thereof.

Respectfully submitted,

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(Date)

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Marked-Up Version of Claims 1, 3, 6-9, 12, 14, 16-17 and 19 in Application No. 09/357,507

1. (Twice Amended) A hydrogen purifying apparatus for oxidizing and removing carbon monoxide in a reformed gas containing carbon monoxide in addition to a main component of hydrogen gas, comprising a reaction segment having a catalyst [layer] bed for oxidizing carbon monoxide, a reformed gas [supplying segment] inlet for supplying said reformed gas to said reaction segment via a reformed gas [supply] pathway, an oxidant gas supplying segment for supplying an oxidant gas [on the path of] to said reformed gas [supply] pathway, [means] a water-cooled apparatus for cooling an upstream side of said catalyst [layer] bed [at an upstream side], and means for heating a downstream side of said catalyst [layer] bed [at a downstream side],

wherein said means for heating the downstream side of said catalyst bed is selected from the group consisting of an electric heater and a portion of the reformed gas pathway formed in proximity with said catalyst bed via a partition so as to heat said downstream side of said catalyst bed by said reformed gas before passing through said water-cooled apparatus.

3. (Twice Amended) The hydrogen purifying apparatus in accordance with claim [2] 1, wherein [said] an upstream side portion of the catalyst bed is formed of different catalyst materials than that of [the] a downstream side portion, and the catalyst constituting said downstream side portion exerts [the] an activity at lower temperature than the catalyst constituting said upstream side portion.

6. (Amended) The hydrogen purifying apparatus in accordance with claim [2] 1, [wherein a supplying amount of said oxidant gas is changed] further comprising a gas flow rate

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control valve capable of changing an amount of oxidant gas to be supplied in correspondence with a temperature of said catalyst [layer] bed.

8. (Twice Amended) The hydrogen purifying apparatus in accordance with claim [7] 1, wherein said reformed gas flows in a first direction prior to passing through said water-cooled apparatus [cooling means], and passes through said catalyst [layer] bed in a second direction, wherein the first direction and second direction are opposing.

9. (Amended) The hydrogen purifying apparatus in accordance with claim [7] 1, wherein said reaction segment is placed [on] outside the [periphery of said flow pathway of said] reformed gas pathway before [the passage] passing through said catalyst [layer] bed.

12. (Twice Amended) The hydrogen purifying apparatus in accordance with claim 1, wherein a branched pathway is formed which bifurcates downstream from a connection between said reformed gas [supply] pathway and said oxidant gas [supply pathway] supplying segment, thereby forming a catalyst [layer] bed heating branch and a catalyst bed cooling branch, the catalyst [layer] bed heating branch being connected to said reaction segment at [the] a middle point of said catalyst [layer] bed, the catalyst [layer] bed cooling branch being connected to said reaction segment at an upstream point of the catalyst [layer] bed.

14. (Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment has at least a two-segmented catalyst [layer] bed and at least an uppermost catalyst [layer] bed has a part with no catalytic function or a part with low reactivity to CO.

16. (Twice Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment comprises an uppermost honeycomb shaped catalyst [layer]

bed and a lowermost honeycomb shaped catalyst layer, where [the uppermost catalyst layer is larger than the lowermost catalyst [layer] bed with respect to an open area at the honeycomb lattice] an open area of a honeycomb lattice of the uppermost catalyst bed is larger than an open area of a honeycomb lattice of the lowermost catalyst bed.

17. (Amended) The hydrogen purifying apparatus in accordance with claim 14, wherein the uppermost catalyst bed comprises a platinum group metal supported by [the] an alumina group material and the lowermost catalyst bed comprises a platinum group metal supported by [the] a zeolite group material.

19. (Amended) The hydrogen purifying apparatus in accordance with claim 14, wherein said catalyst [layer] bed [obtains] contains a temperature measuring apparatus segment and means for controlling a supplying amount of said oxidant gas according to a temperature as measured.

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Marked-Up Version of the Specification In Application No. 09/357,507

The paragraph beginning at page 17, line 29 and ending at page 18 line 22:

FIG. 3 is a schematic cross-sectional view illustrating the hydrogen purifying apparatus in Embodiment 1-2. In Figure 3, several of the reference numerals refer to items that are also shown in Figure 1, but different reference numerals are used in Figure 1. Reference numeral 13 in Figure 3 and reference numeral 3 in Figure 1 both refer to the air supply duct. Reference numeral 14 in Figure 3 and reference numeral 4 in Figure 1 both refer to the air flow rate control valve. Reference Numeral 15 in Figure 3 and reference numeral 5 in Figure 1 both refer to the cooled water supply duct. Reference Numeral 16 in Figure 3 and reference numeral 6 in Figure 1 both refer to the cooled water volume control valve. Reference numeral 19 and numeral 10 both refer to the reformed gas outlet. A provision of the heat exchange fin 20 close to the side wall around the downstream side of the catalyst layer 11 helps to heat the downstream side of the catalyst layer 11. Such structure also facilitates cooling the reformed gas by a heat exchanger 17. Moreover, since the reformed gas flow pathway thermally insulates the catalyst layer 11, the temperature distribution in the center and the periphery of the catalyst layer 11 becomes homogeneous, thereby enabling efficient oxidation of CO. Due to the structure of the apparatus such that the reformed gas passes through the catalyst layer 11 in an opposing direction of stream to that before passing through the heat exchanger 17, the reformed gas at elevated temperature can exchange heat with the downstream side of the catalyst layer 11 and is cooled. Because the reformed gas thus cooled then passes along the upstream side of the catalyst layer 11, the temperature of the catalyst layer 11 can be lowered at the upstream side and

elevated at the downstream side. As a result, the temperature distribution can be optimized in response to selective oxidation of CO by the catalyst.

The paragraph beginning at page 19, line 17 and ending at page 20 line 3.

FIG. 4 is a schematic cross-sectional view illustrating the hydrogen purifying apparatus in Embodiment 1-3. <u>In Figure 4, several of the reference numerals refer to items that are also shown in Figure 1, but different reference numerals are used in Figure 1. Reference numeral 23 in Figure 4 and reference numeral 4 in Figure 1 both refer to the air flow rate control valve. Reference numeral 25 in Figure 4 and reference numeral 5 in Figure 1 both refer to the cooled water supply duct. Reference numeral 26 in Figure 4 and reference numeral 6 in Figure 1 both refer to the cooled water volume control valve. Reference numeral 29 in Figure 4 and reference numeral 10 in Figure 1 both refer to the reformed gas outlet.</u> A provision of the heat exchange fin 30 on the wall of the reformed gas flow pathway neighboring the downstream side of the catalyst layer 21 helps to heat the downstream side of the catalyst layer 21 while cooling the reformed gas. Such structure also facilitates cooling by a heat exchanger 27. In the event that the flow rate of the reformed gas is increased, cooling only by the heat exchanger proves insufficient occasionally when the temperature is elevated greatly due to oxidation heat by CO and hydrogen. However, the structure of the apparatus of this embodiment where heat is radiated from the periphery of the reaction chamber 28 enables to minimize elevation of the temperature of the catalyst layer 21. Therefore, the apparatus can cope with any increases in load due to increased flow rate of the reformed gas.

The paragraph beginning at page 20, line 18 and ending at page 20 line 29.

FIG. 5 is a schematic cross-sectional view illustrating the hydrogen purifying apparatus in Embodiment 1-4. In Figure 5, several of the reference numerals refer to items that are also shown in Figure 1, but different reference numerals are used in Figure 1. Reference numeral 34 in Figure 5 and reference numeral 3 in Figure 1 both refer to the air supply duct. Reference numeral 35 in Figure 5 and reference numeral 4 in Figure 1 both refer to the air flow rate control valve. Reference numeral 36 in Figure 5 and reference numeral 5 in Figure 1 both refer to the cooled water supply duct. Reference numeral 37 in Figure 5 and reference numeral 6 in Figure 1 both refer to the cooled water volume control valve. Reference numeral 41 in Figure 5 and reference numeral 10 in Figure 1 both refer to the reformed gas outlet. The operable temperature range of the catalyst selectively oxidizing CO varies depending on the species of rare metal contained in the catalyst, type of carrier and the like. In the present embodiment, for the first catalyst layer 31, a catalyst operable at high temperatures is used and for the second catalyst layer 32, a catalyst operable at low temperatures. More specifically, a platinum-carrying zeolite was used for the first catalyst layer 31 and a platinum-carrying alumina for the second catalyst layer 32.

The paragraph beginning at page 23, line 2 and ending at page 23 line 16.

FIG. 7 is a schematic cross-sectional view illustrating the hydrogen purifying apparatus in Embodiment 1-5. In Figure 7, several of the reference numerals refer to items that are also shown in Figure 1, but different reference numerals are used in Figure 1. Reference numeral 58 in Figure 7 and reference numeral 5 in Figure 1 both refer the cooled water supply duct. Reference numeral 59 in Figure 7 and reference numeral 6 in Figure 1 both refer to the

cooled water volume control valve. Reference numeral 60 in Figure 7 and reference numeral 7 in Figure 1 both refer to the heat exchanger. In the present embodiment, for the first catalyst layer 51, a catalyst operable at low temperatures is used and for the second catalyst layer 52, a catalyst operable at high temperatures is used. When the first catalyst layer 51 is increased in temperature greatly due to reaction between CO and air, the catalyst loses the ability to selectively oxidize CO occasionally. Therefore, air supply from a first air supply duct 54 to the first catalyst layer 51 is reduced by providing the second catalyst layer 52 and the second air supply duct 55 in order to suppress temperature rises at the first catalyst layer 51. As a result, CO can be removed efficiently.

The paragraph beginning at page 31, line 2 and ending at page 31 line 5.

A catalyst reaction segment 103 is connected to a material gas supply pathway 105 connected to a material gas supplying segment 101, a material gas exhaust duct 109 connected to a fuel cell, and a branched pathway 108. One branched pathway 108 functions as the cooling branch and the other branched pathway 108 functions as the heating branch.

The paragraph beginning at page 13, line 28 and ending at page 14, line 6

FIG. 1 is a schematic cross-sectional view of the hydrogen purifying apparatus in Embodiment 1-1 in accordance with the present invention. As shown in FIG. 1, the hydrogen purifying apparatus comprises a catalyst layer 1, a reformed gas inlet 2, an air supply duct 3, an air flow rate control valve 4, a cooled water supply duct 5, a cooled water volume control valve 6, a heat exchanger 7, a heater 8, a reaction chamber (or reaction segment) 9, a reformed gas outlet 10, and a reformed gas pathway 12.